(12) UK Patent Application (19) GB (11) 2 336 508 (13) A

(43) Date of A Publication 20.10.1999

(21) Application No 9904575.9

(22) Date of Filing 26.02.1999

(30) Priority Data

(31)	(32)	(33)
9804640	04.03.1998	GB
9804639	04.03.1998	

(51) INT CL^{6}
H04Q 7/32 // H04B 7/185 7/26

(52) UK CL (Edition Q)
H4L LECTP L1H8A

(56) Documents Cited
US 5239557 A

(58) Field of Search
UK CL (Edition Q) H4L LDGX LDH LDRS LECSV LECSX LECTP LETXX
INT CL^{6} H03G 3/20 3/30 , H04B 7/005 7/155 7/185 7/212 7/26 , H04Q 7/22 7/32
Online Databases: WPI, EPODOC, JAPIO

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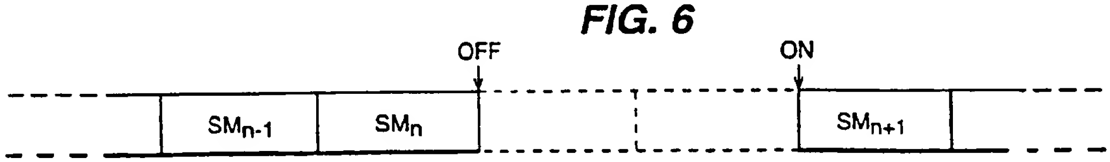
(54) Abstract Title
Data carrier deactivation in absence of user data

(57) In a radio communications system in which data is transmitted on a modulated radio frequency carrier, the carrier is switched off when no data is available for transmission. If repeated signalling information is required to be transmitted, only a predetermined number of repeats are transmitted before the carrier is switched off. In one embodiment a bit sequence at the end of a first data block is compared with multiple sequences from a second block and if all sequences are equal, transmission of the second block is inhibited. In another embodiment data input for transmission is compared with a predetermined bit sequence. If a match is found for any relative bit alignment, this indicates an idle state (absence of user data) and the carrier is switched off. When more user data is received the carrier is switched on and frames are transmitted in synchronisation with the timing of frames transmitted before carrier deactivation. After carrier reactivation a constant power preamble may be transmitted to assist in level control in the transmitter. In a satellite SCPC system satellite power efficiency is improved and mobile earth station battery power is saved.

FIG. 6



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

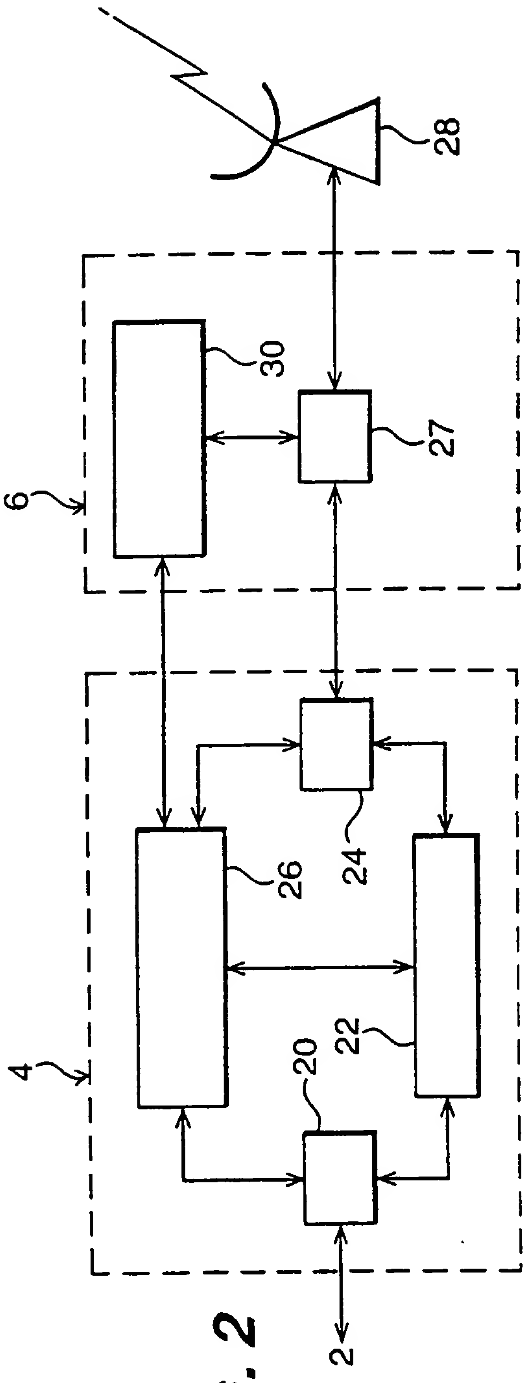


FIG. 2

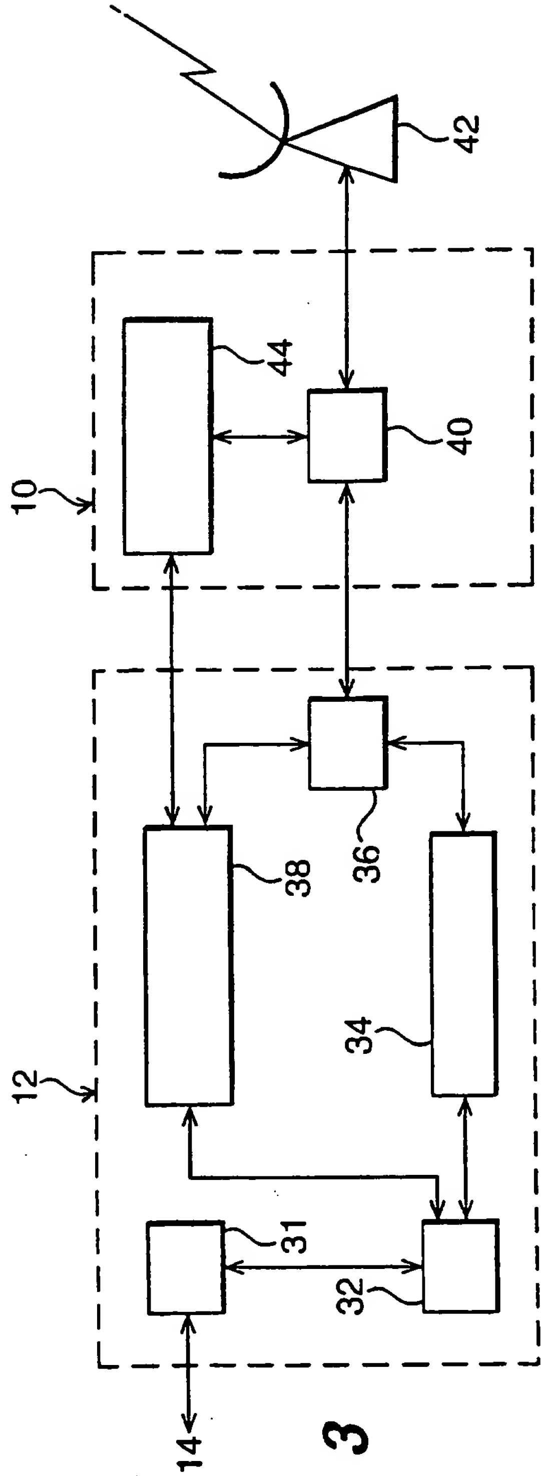


FIG. 3

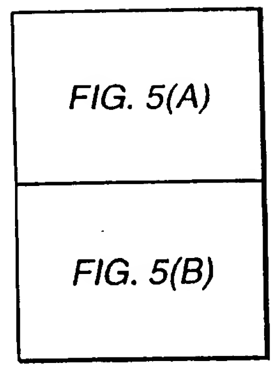


FIG. 5

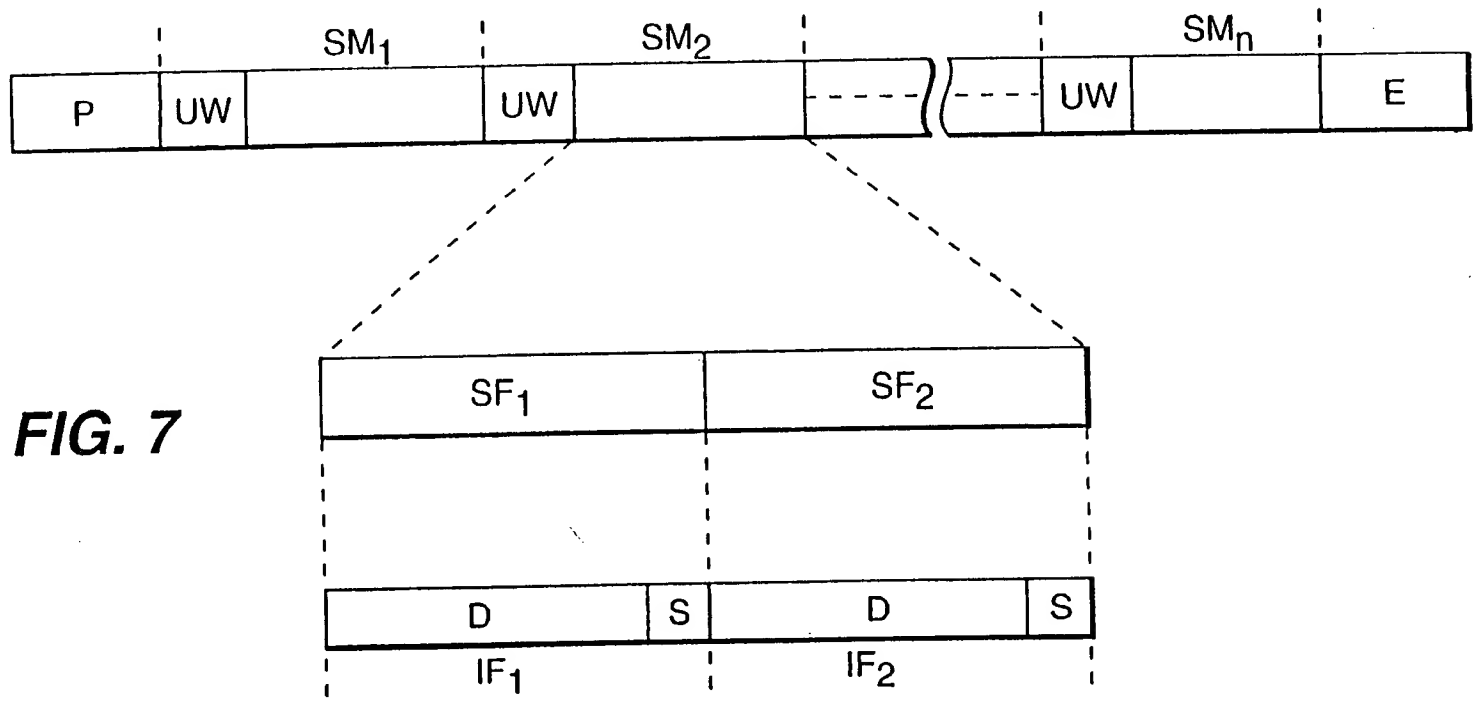


FIG. 7

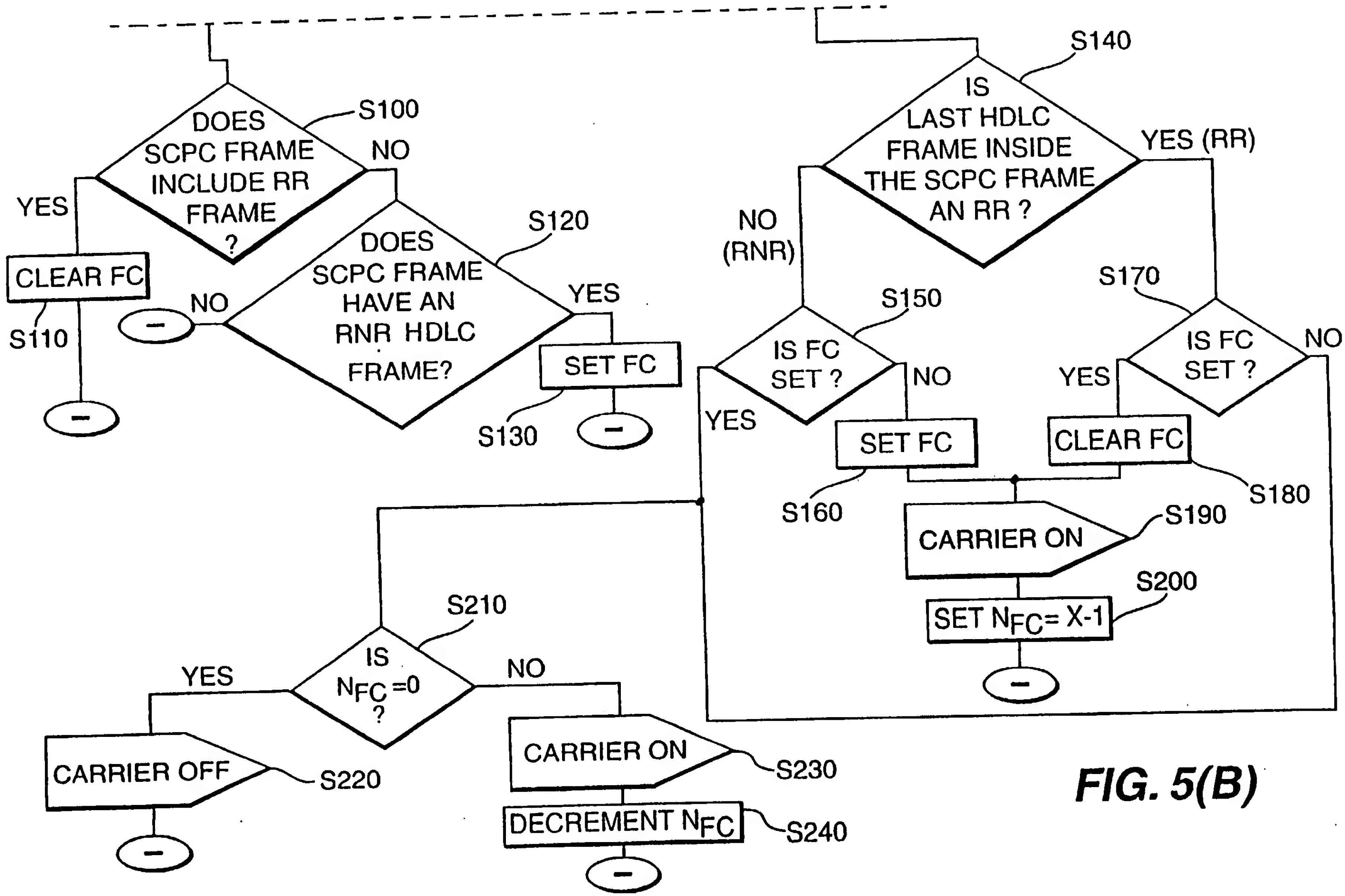

DOES SCPC FRAME INCLUDE RR FRAME ?
S100
YES
NO
CLEAR FC
S110
DOES SCPC FRAME HAVE AN RNR HDLC FRAME?
S120
YES
NO
SET FC
S130
IS LAST HDLC FRAME INSIDE THE SCPC FRAME AN RR ?
S140
YES (RR)
NO (RNR)
IS FC SET ?
S150
YES
NO
SET FC
S160
IS FC SET ?
S170
YES
NO
CLEAR FC
S180
CARRIER ON
S190
SET NFC= X-1
S200
IS NFC =0 ?
S210
YES
NO
CARRIER OFF
S220
CARRIER ON
S230
DECREMENT NFC
S240

FIG. 5(B)

FIG. 9

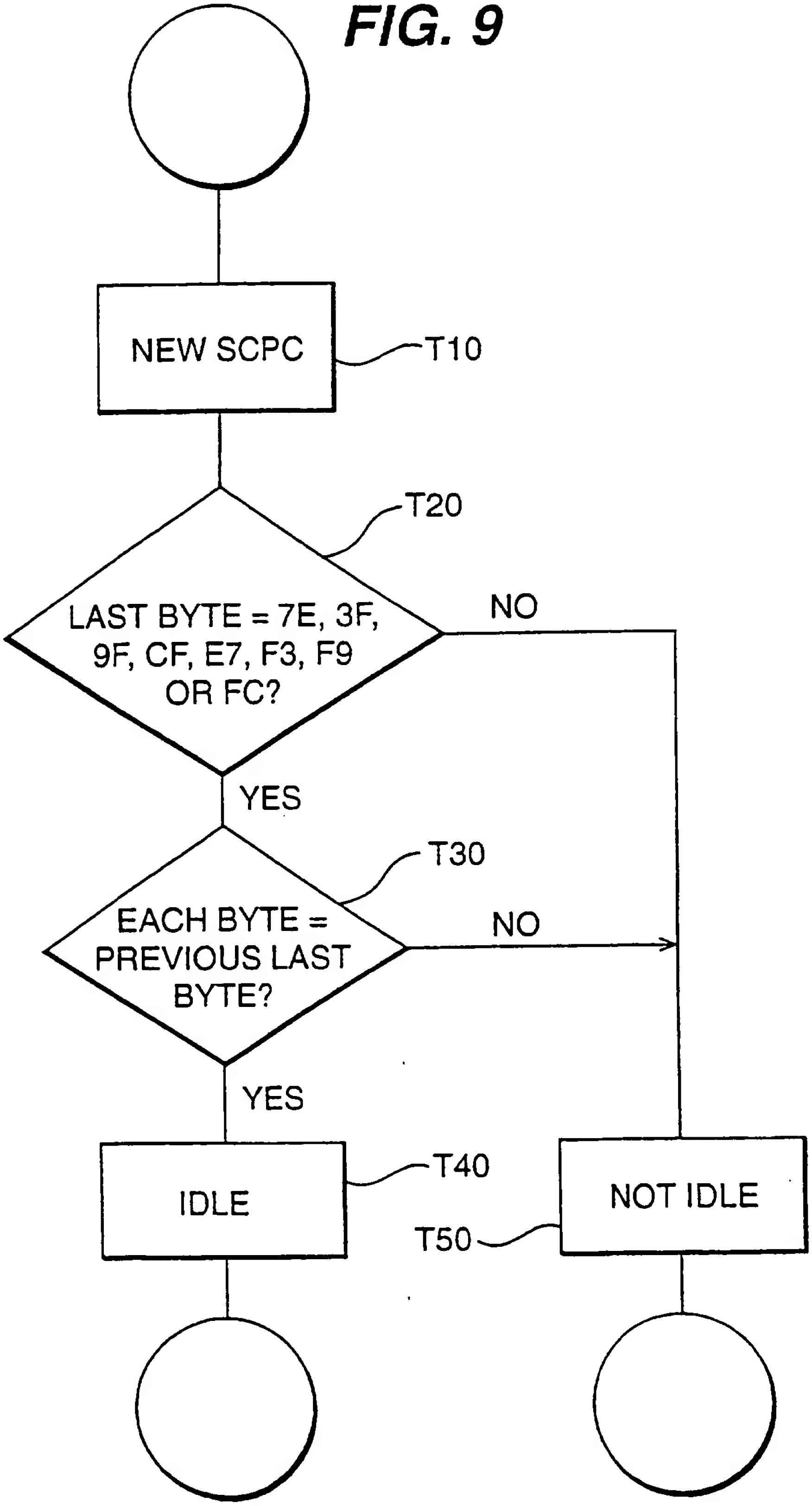
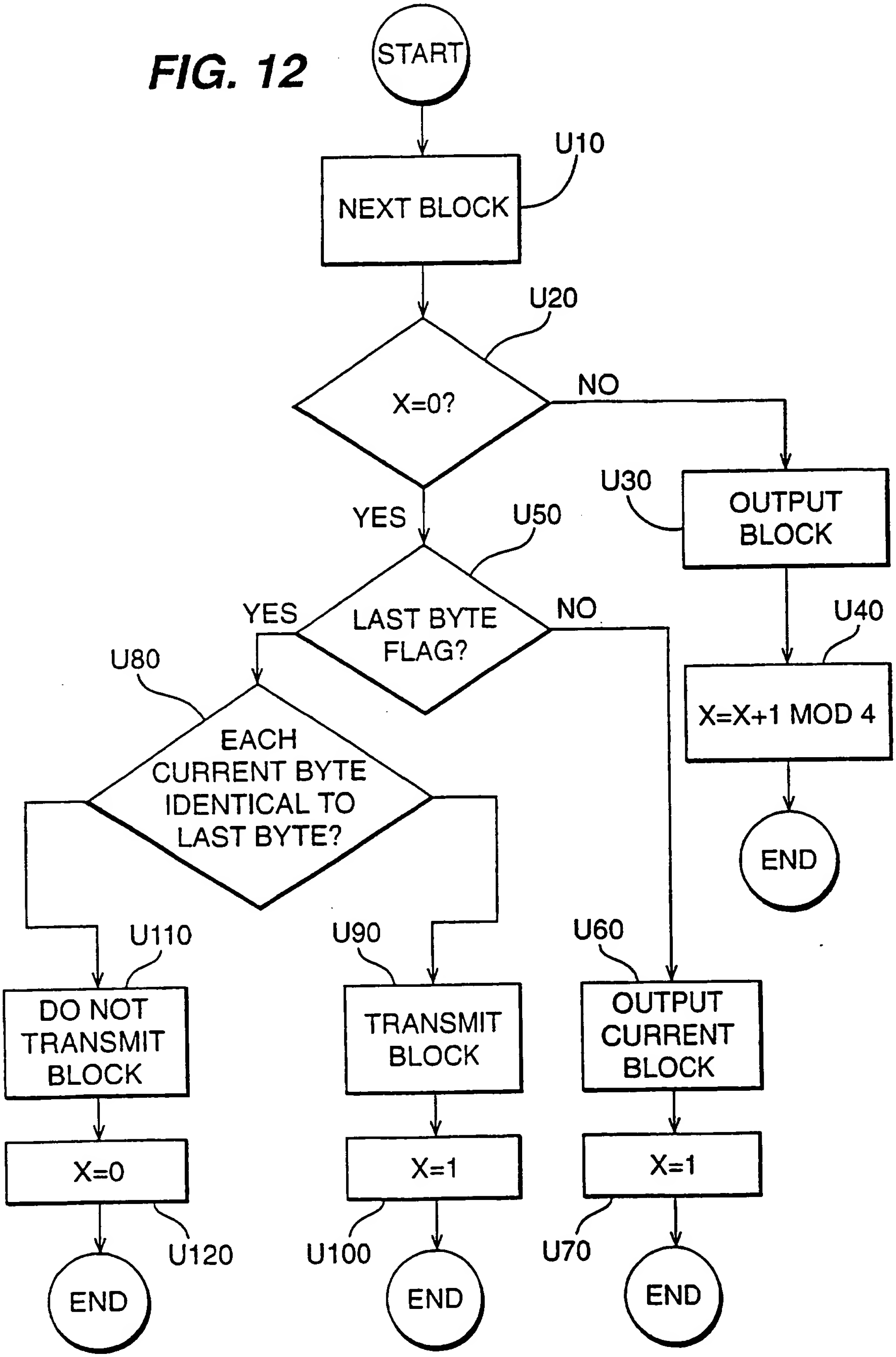

NEW SCPC
T10
T20
LAST BYTE = 7E, 3F, 9F, CF, E7, F3, F9 OR FC?
NO
YES
T30
EACH BYTE = PREVIOUS LAST BYTE?
NO
YES
IDLE
T40
NOT IDLE
T50

FIG. 12


START
NEXT BLOCK
U10
U20
X=0?
NO
YES
U30
OUTPUT BLOCK
U40
X=X+1 MOD 4
END
U50
LAST BYTE FLAG?
YES
NO
U80
EACH CURRENT BYTE IDENTICAL TO LAST BYTE?
U110
DO NOT TRANSMIT BLOCK
X=0
U120
END
U90
TRANSMIT BLOCK
X=1
U100
END
U60
OUTPUT CURRENT BLOCK
X=1
U70
END

CARRIER ACTIVATION FOR DATA COMMUNICATIONS

The present invention relates to a data communication method and apparatus, and in particular such an apparatus for carrier activation in a satellite communication system.

In satellite voice communication systems, it is known to switch the carrier off in one direction over the satellite link when the party transmitting in that direction is not talking. This technique is known as 'voice activation' or more generally 'carrier activation' and is described for example on page 55, section 3.2 of 'Satellite Communications - Principles and Applications' by Calcutt and Tetley, First Edition 1994, published by Edward Arnold. The average English speaker only talks during about 40% of the time during a telephone conversation, and therefore a satellite power saving of up to 4 dB can be achieved by this technique.

The document US 5481561 mentions that carrier activation could be applied to voice, facsimile and data communications, but recognizes that this is difficult to realize in practice.

Carrier activation in fax calls has been implemented in the Inmarsat-M™, Inmarsat-B™ and Inmarsat-mM™ satellite services. The deterministic nature of the ITU T.30 protocols, to which Group 3 fax terminals conform, is used to detect when one terminal is about to receive page data and will therefore not be transmitting; the carrier for transmission by that terminal is then switched off.

deactivation of the carrier. The interval between transmission of frames may be an integral number of frame periods, or an integral number of fractions of a frame period, such as quarters of a frame period.

An advantage of this aspect of the invention is that a receiver may receive and decode the frames transmitted after the reactivation of the carrier without having to reacquire the frame timing. Furthermore, carrier activation may be implemented in this way as an additional feature to an existing satellite SCPC system without modification of frame formatting protocols.

According to another aspect of the present invention, there is provided a method and apparatus of inhibiting transmission of a block of repeated data by detecting whether the last byte of a previous block is the same as each byte of the current block and inhibiting transmission of the current block if this is the case. Preferably, the carrier on which the blocks are transmitted is deactivated or reduced in power during the period in which the current block would otherwise be transmitted.

According to another aspect of the present invention, there is provided a method of transmitting a burst of information after a period of carrier deactivation, in which a constant power level preamble is transmitted before the information. Advantageously, this assists in automatic level control of the transmitter.

Specific embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 12 is a flowchart of an algorithm performed by the transmitting MIU on each data block in the third embodiment; and

Figure 13 is a flowchart of an algorithm performed by the receiving MIU in the third embodiment.

The overall layout of a satellite communications system, when used for data communications, is shown in Figure 1. One example of such a system is the INMARSAT-B (TM) or INMARSAT-M (TM) satellite communications system, as described for example in Chapters 12 and 14 of "Satellite Communications: Principles and Applications" by Calcutt and Tetley, 1st edition, published by Edward Arnold. The following system is also described in WO96/31040, the contents of which are incorporated herein by reference.

A mobile DTE 2 is connected via an RS232C interface to a modem interface unit (MIU) 4. The MIU 4 simulates a Hayes - compatible modem and is able to decode Hayes-type commands from the mobile DTE 2, so that off-the-shelf communications software may be used in the mobile DTE 2. The MIU 4 does not perform modulation or demodulation in this case, since it is not connected to an analog line. Instead, the MIU 4 provides an interface to a mobile earth station (MES) 6 which allows communication via a satellite 8 to a fixed or land earth station (LES) 10. The LES 10 is connected to an LES MIU 12 which interfaces the satellite link to a network 14, in this case a public switched telephone network (PSTN), and functions as a modem to convert analog signals on the PSTN 14 to digital signals on the satellite link,

also includes access control and signalling equipment (ACSE) 30, for setting up and clearing the satellite link, which exchanges data with the controller 26 of the mobile MIU 4.

The MES ACSE 30 communicates with a network control station (NCS) which allocates communications channels, supervises communications traffic through the satellite 8 and communicates with further ACSE at the LES.

The mobile MIU 4, MES 6 and ACSE 30 may be integrated in a mobile unit and the antenna 28 may be integrated or connected externally with the mobile unit.

Figure 3 shows the LES 10 and the LES MIU 12 in greater detail. The LES MIU 12 includes a modem 31 for demodulating analog signals from the PSTN 14 and modulating digital signals for the PSTN 14, and a modem interface 32 which supports modem protocols such as V.42 error correction, for communication with the modem 16.

The modem interface 32 is connected through a buffer 34 to an LES interface 36, which implements protocols compatible with the MES interface 24, so that data can be exchanged between the LES MIU 12 and the MES MIU 4. A controller 38 supervises the operation of the modem interface 32, buffer 34 and LES interface 36. The LES interface 36 is connected to an RF modulator/demodulator 40 which modulates signals for transmission to the satellite 8 through an antenna 42, and demodulates signals received from the

As described above, the MIU formats the data to be transmitted into HDLC frames. Multiple HDLC frames are formatted into one single channel per carrier (SCPC) frame, as shown in Figure 4. The transmission begins with a header portion P, followed by a sequence of fixed-length SCPC frames SM_1, SM_2, ... SM_n. The end of the transmission is indicated by an end signal E.

Each SCPC frame SM is subdivided into four sections, each containing a header H_1, H_2, H_3, H_4, a data field D_1, D_2, D_3, D_4, and dummy bits (shaded). The data fields D_1 and D_2 together form one or more HDLC frame, which is repeated in the data fields D_3 and D_4, to increase the energy per bit. The contents of each HDLC frame depend on whether data or control information is being sent.

If data is being sent, the HDLC frame has an information (I) format formed from the concatenated data fields D_1 and D_2. The HDLC frame includes control bytes C containing acknowledgement and frame number information indicating the sequence number of the transmitted frame and the sequence number of the last frame received correctly.

Line control messages are sent as unnumbered information (UI) HDLC frames, more than one of which may be contained within the data fields D1 and D2. Flow control messages are sent in a supervisory (S) HDLC frame format.

The LES MIU 12 and the MES MIU 4 are programmed to generate either RR (Receive Ready) or RNR (Receive Not Ready) HDLC flow control

transmitted during call set-up to establish the parameters of the call. If so (S50), the MIU sets the carrier state as 'OFF' (S55) if the counter N_E (number of Establish LCM) is zero; if N_E is not zero, it is decremented (S60) and the carrier state is set 'ON' (S65). In either case, the algorithm restarts. As a result, sufficient 'Establish LCM' frames are transmitted to ensure that one is received, before the carrier is deactivated.

If the SCPC frame is not an 'Establish LCM', the MIU next detects (S70) whether $N_{rp} = N(R)$, where N(R) is a variable defined in the HDLC protocol and represents the serial number of the next expected I (information) frame. If the current SCPC frames contains more than one HDLC frame each having an N(R) value, the most advanced N(R) value is taken. If $N_{rp} \neq N(R)$, N_{rp} is set to N(R) (S80), the carrier state is set as 'ON' (S95) and the algorithm proceeds to step S100.

If $N_{rp} = N(R)$, the MIU detects (S90) whether the SCPC frame contains only RNR or RR HDLC frames. If not, the carrier state is set as 'ON' (S95) and the algorithm proceeds to step S100. At step S100, the MIU detects whether the SCPC frame includes an RR frame. If so, the flow control flag FC is cleared (step S110) and the algorithm restarts. If not, the MIU detects (S120) whether the SCPC frame includes an RNR frame and sets the FC flag (S130) if it does. In either case, the algorithm then restarts.

If the MIU detects at step 90 that the SCPC frame does contain only RR or RNR frames, this means that no user data is present, but the MIU must

ISDN application. In this embodiment, the network 14 is an ISDN and the satellite 8 has a multibeam user antenna for communication with the MES 6, in order to increase the gain of the user link and support a higher data rate. In this embodiment the LES MIU 12 provides an ISDN interface to the network 14, while the MES MIU 4 simulates an ISDN terminal adapter for the mobile DTE 2. Since the MES MIU 4 does not simulate a modem in this embodiment, it does not decode the Hayes™ AT command set and is preferably integrated with the MES 6. In the second embodiment, a 16 QAM modulation scheme is used for transmission, such that transmitted data has a variable power envelope. Further details of the modulation and coding schemes are described in co-pending application GB 9804639.4, the contents of which are incorporated by reference in so far as they relate to a 64 kbit/s satellite channel.

As shown in Figure 7, the format used for data transmission in this embodiment comprises SCPC frames SM_1, SM_2 ... SM_n each having as a header a unique word UW to assist synchronisation in the receiver. The end of a sequence of SCPC frames is indicated by an end of data signal E. Each SCPC frame contains two subframes SF1 and SF2. Each subframe SF is encoded from an input frame IF1, IF2 which contains a data field D of fixed length (in this case 2560 bits) and a signalling field S. Each data field D contains HDLC frames transmitted by an ISDN application on the mobile DTE 2 or the fixed DTE 18.

Table 1

HDLC Flag Representation with Bit Shift

Number of Bits Shifted	Binary	Hex
0	01111110	7E
1	00111111	3F
2	10011111	9F
3	11001111	CF
4	11100111	E7
5	11110011	F3
6	11111001	F9
7	11111100	FC

In this embodiment, the MIU performs the algorithm shown in Figure 9 in order to detect an SCPC frame consisting entirely of flags, which therefore need not be transmitted. At step T10, the MIU assembles the data content of the input frames IF1 and IF2 of the current SCPC frame. At step T20, the MIU checks whether the value of the last data byte of the preceding SCPC frame had any of the hex values shown in Table 1 above. If so, the MIU then detects (T30) whether all of the data bytes in the current SCPC frame are equal to the last data byte of the preceding SCPC frame. If so, this indicates that the entire current SCPC frame consists of HDLC flags and an 'idle' state is set (T40). If either of the tests of T30 and T40 are not satisfied, the 'idle' state is not set (T50).

reading the input bits into an 8-bit shift register and continuously comparing the contents with hex 7E. However, the transmission of the current SCPC frame cannot be interrupted immediately when a flag is detected without violating the frame format, so this option does not confer any advantage in implementing carrier activation and requires a greater processing overhead than the second embodiment.

An optional feature of the frame format of Figure 10 is shown in dotted outline. In this arrangement, a short preamble P is transmitted at the beginning of a burst of frames SM, as soon as the carrier has been reactivated.

The preamble P comprises a repeated sequence of the same 16 QAM symbol, having a power level equal to the average power level of the 16 QAM constellation. The sequence comprises 16 symbols transmitted at a rate of 33.6 kSymbol/s, having a total duration of 476 μs.

The transmission of the preamble assists in automatic level control using a feedback loop in a high-power amplifier (HPA) in the MES RF modulator 27 and the LES RF modulator 40, so that the transmit power can be ramped up to the required level in 500 μs or less.

If the preamble P were not transmitted at the beginning of each burst, the transmission would begin with a unique word which does not have a constant power level, and would then not allow the HPA level to stabilise in the required time.

At step U10, the MIU starts processing the next 20 ms block d. At step U20 the MIU detects whether the block is the first block in a frame SM. A position pointer X counts the position of the current block within the frame, so that at step U20, the MIU detects whether X=0. If X is not zero, this indicates that a previous block in the current frame has already been sent for transmission. Because the MIU cannot interrupt a frame SM once transmission has begun, the current block is then output for scrambling and encoding at step U30 and the counter X is incremented modulo 4 at step U40, to indicate the frame position of the next block to be checked.

If X is zero, indicating that the block, if transmitted, will be first block of a frame, then the MIU detects at step U50 whether the last byte of the previous block was equal to hex 7E, 3F, 9F, CF, E7, F3, F9, or FC. If not, this indicates that idle flags may not be present in the current block and the current block is output for transmission, at step U60. At step U70, X is set to 1, indicating that the next block will be the second block in the frame.

If, on the other hand, the result of the test at step U50 is positive, the MIU detects at step U80 whether each byte of the current block is identical to the last byte of the previous block, as detected at step U50. If not, this indicates that the current block probably contains at least some data other than flags, so the data is output for transmission at step U90, and X is set to 1 at step U100. Otherwise, if the result of the test at step U80 is positive, the current block is not output for transmission at step U110, the carrier is turned

The algorithms of Figures 9, 12 and 13 are designed specifically to look for an HDLC hex 7E flag, but may be modified to look for any repeating byte entirely filling a frame or block, and to turn the carrier off if the repeating byte is also the last byte in the previous transmitted frame or block. The receiving MIU would then output the repeated byte a number of times corresponding to the period for which the carrier is switched off. Thus, power can be saved by not transmitting repeated user data, as well as repeated flags. The receiving MIU infers that the last byte of the previous frame should be repeated if the carrier is switched off, but must maintain timing synchronisation to calculate the correct number of repetitions. However, since the carrier is switched off for an integral number of blocks or frames, the receiving MIU need only be able to detect the carrier deactivation interval with a resolution of one block or frame, so that the local clock reference of the receiving MIU would be sufficient.

The above embodiments have been described with reference to an 8-bit HDLC protocol, but are applicable to other communications protocols with different idle sequences. For example, in a 16-bit variant of HDLC, the idle flag is hex 7FFE, so the carrier activation algorithm would look for bit-shifted versions of that flag instead. Alternatively, some protocols may use an all-zero or all-one byte (e.g. hex 00 or FF) as an idle flag. In that case, there would be no need to look for bit-shifted versions of the idle flag, but the carrier would be deactivated if a block or frame contained all zeros or all ones. Other

In the above embodiments, a carrier is deactivated completely if there is only redundant data to be sent. Alternatively, however, the power level of the carrier could be reduced and optionally a synchronising sequence such as a unique word transmitted at reduced power during the deactivation period; this reduces the power requirements of an MES if implemented on an MES MIU and of a satellite if implemented on an LES MIU. Hence, references herein to 'deactivating' a carrier encompass the continued transmission on a carrier at reduced power while not transmitting any user data or level signalling information.

In the specific description above, the apparatus is illustrated in terms of functional blocks, for ease of explanation. However, these blocks do not necessarily correspond to discrete physical units.

comparing a series of bits of a predetermined length at the end of a first block with multiple sequential series of bits of said predetermined length comprising a second block, and

if all of said series are equal, inhibiting transmission of said second block.

5. A method as claimed in claim 4, further comprising deactivating or reducing the power level of a carrier transmitted by the radio frequency transmitter for at least approximately a transmission time corresponding to the length of said second block.

6. A method as claimed in claim 4 or claim 5, further comprising formatting the blocks into frames prior to transmission, each of the blocks being of the same length and each of said frames comprising the same, integral number of said blocks.

7. Communications interface apparatus for connection between a source of data, including user data, and a transmitter, said data having a format in which an absence of user data is indicated by a predetermined bit sequence,

the apparatus being arranged to output said user data to said transmitter for transmission on a modulated radio frequency carrier,

11. Apparatus as claimed in any one of claims 7 to 10, arranged subsequently to reactivate said carrier when no said match is found.

12. A method of carrier deactivation, comprising:

receiving data, including user data, in a format in which an absence of user data is indicated by a predetermined bit sequence, and transmitting said user data on a modulated radio frequency carrier, the method including:

comparing a series of bits of said data with said predetermined bit sequence, with a plurality of different relative bit alignments, and

deactivating said carrier if a match is found with any of said bit alignments.

13. A method as claimed in claim 12, wherein said comparing step comprises comparing said series of bits, having a length equal to that of the predetermined bit sequence, with each of a set comprising said predetermined bit sequence and all bit-shifted permutations thereof.

14. A method as claimed in claim 13, wherein said data is formatted in a series of constant length frames or blocks, the comparing step comprising comparing each said sequential series of data bits of one of said frames or blocks and the last said series of data bits of the previous one of said frames or blocks with each of said set, and deactivating the carrier such that said one

18. Apparatus as claimed in claim 17, wherein said signalling information is an HDLC line control message.

19. Apparatus as claimed in claim 17, wherein said signalling information is a flow control message.

20. A method of carrier deactivation, comprising:

receiving data, including both user data and signalling information, and transmitting said user data on a modulated radio frequency carrier, the method including:

detecting the presence of repeated signalling information and the absence of user data in said data, and

deactivating said carrier if the number of repetitions of said signalling information is equal to or exceeds a predetermined value, such that said excess repetitions are not transmitted.

21. A method as claimed in claim 20, wherein said signalling information is an HDLC line control message.

22. A method as claimed in claim 20, wherein said signalling information is a flow control message.

the step of selective transmission comprising detecting whether at least an initial portion of each frame contains no information or only redundant information, and deactivating the carrier such that said portion of the frame is not transmitted,

wherein, after the carrier is deactivated, subsequent frames are transmitted with a timing synchronised with that of frames transmitted prior to said deactivation.

26. A method as claimed in claim 25, wherein the detecting step comprises detecting whether the whole of each of said frames contains no information or only redundant information.

27. A method of transmitting a data burst via satellite to a receiving terminal, comprising:

transmitting the data burst in a format comprising one or more frames having a variable power level modulation, preceded by a preamble having a constant power level.

28. A method as claimed in claim 27, wherein the power level of said preamble is approximately equal to the average power level of said one or more frames.

The Patent Office

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Application No:	GB 9904575.9	**Examiner:**	Gareth Griffiths
Claims searched:	1-6	**Date of search:**	12 August 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4L (LDGX, LDH, LDRS, LECSV, LECSX, LECTP, LETXX)

Int Cl (Ed.6): H03G 3/20, 3/30, H04B 7/005, 7/155, 7/185, 7/212, 7/26, H04Q 7/22, 7/32

Other: Online Databases: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US5239557 (DENT)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.